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(54) Engine fuel injection apparatus

(57) The invention enables reduction of the numbers of the pipes in fuel piping and joint parts and to facilitate piping work, maintenance and inspection work.

An engine fuel injection apparatus 100 includes first fuel injection valves 103... provided on an upstream side of an air intake passage of an engine, second fuel injection valves 104 ... provided on a downstream side of the air intake passage, and a fuel pump 95 for supplying fuel to the first and the second fuel injection valves. The second fuel injection valve is positioned at a level lower than the first fuel injection valves, and the fuel pump is connected to the second fuel injection valves via the first fuel injection valves by fuel feed pipes 105, 106 so that fuel does not return to a fuel tank 34.

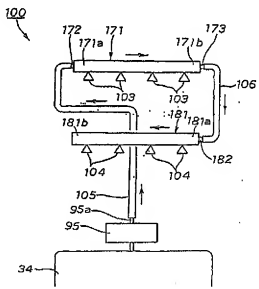

FIG. 10

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Description

[0001] The present invention relates to an improvement of an engine fuel injection apparatus.

[0002] In a motorcycle, an engine fuel injection apparatus is known (for example, JP-A-2000-97132 (P.3-4, Figs.1-3)).

[0003] According to this document, an engine fuel injection apparatus in the related art includes a first fuel injection valve provided on an upstream side of an engine throttle valve, and a second fuel injection valve on a downstream side of the throttle valve, and is characterized in that fuel is supplied to the first and the second fuel injection valves by a fuel pump.

[0004] However, in the engine fuel injection apparatus in the related art, a fuel feed pipe from the fuel pump is branched and connected to the first fuel injection valve and the second fuel injection valve, respectively, and remaining fuel is returned to a fuel tank from the first and the second fuel injection valves via a return pipe. Therefore, a number of pipes in fuel piping and coupling parts are required, and the direction of assembly is limited. Therefore, piping work, maintenance, and inspection are cumbersome.

[0005] Accordingly, an object of the present invention is to provide a technology which can reduce the numbers of the pipes in fuel piping and the coupling parts, and facilitate piping work, maintenance, and inspection.

[0006] In order to achieve the object described above, Claim 1 claims an engine fuel injection apparatus including a first fuel injection valve provided on an upstream side of an air intake passage of an engine, a second fuel injection valve provided on a downstream side of the air intake passage, and a fuel pump for supplying fuel to the first and the second fuel injection valves, characterized in that the fuel pump is connected to the second fuel injection valve via the first fuel injection valve or to the first fuel injection valve via the second fuel injection valve by a fuel feed pipe, so that fuel does not return to a fuel tank.

[0007] Since the fuel pump is connected to the second fuel injection valve via the first fuel injection valve or to the first fuel injection valve via the second fuel injection valve by the fuel feed pipe, so that fuel does not return to the fuel tank, a return pipe is not necessary and thus the number of fuel feed pipes may be reduced correspondingly, and the number of joints (joint parts) of the fuel feed pipes may be reduced as well. Therefore, fuel piping may be simplified. In addition, since maintenance and inspection are facilitated, the workability is improved.

[0008] Claim 2 is characterized in that the fuel pump is connected to the second fuel injection valve via the first fuel injection valve by the fuel feed pipe, the first fuel injection valve is a fuel injection valve for the high-speed operation that injects fuel when the number of revolution of the engine is high, and the second fuel injection valve is a fuel injection valve for the low-speed operation that injects fuel when the number of revolution of the engine is low.

While the engine is in operation, fuel is constantly injected from the second fuel injection valve for the low-speed operation. Therefore, even when a small quantity of air is mixed in fuel in fuel piping, it is injected in an early stage and constantly from the second fuel injection valve. Therefore, the quantity of air trapped in the first fuel injection valve for the high-speed operation is negligible, and thus the engine can maintain a stable performance.

[0009] Claim 3 is characterized in that the fuel pump is connected to the first fuel injection valve via the second fuel injection valve and the first fuel injection valve is disposed at the level higher than the second fuel injection valve by the fuel feed pipe.

Fuel is supplied to the second fuel injection valve, which is located at the lower level on ahead. When the engine is in operation, fuel is constantly injected from the second fuel injection valve, which is located at the lower level. Therefore, even when a small quantity of air is mixed in fuel in fuel piping, it is injected in an earlier stage and constantly from the second fuel injection valve. Consequently, the quantity of air trapped in the first fuel injection valve located at a higher level is negligible, and thus the engine can maintain its performance in more stable manner.

[0010] Exemplary embodiments of the present invention will be described below with reference to the accompanying drawings.

Fig. 1 is a left side view of a motorcycle according to the present invention.

Fig. 2 is a left side view of a vehicle body according to the preset invention.

Fig. 3 is a plan view of the vehicle body according to the present invention.

Fig. 4 is a plan view of a seat rail according to the present invention.

Fig. 5 is an exploded view of the seat rail according to the present invention.

Fig. 6 is a left side view showing the area around an engine, a fuel tank, and an air chamber.

Fig. 7 is a left side cross-sectional view of a fuel injection apparatus according to the present invention.

Fig. 8 is a plan view of the fuel injection apparatus according to the present invention.

Fig. 9 is an exploded view of the air chamber according to the present invention.

Fig. 10 is a schematic diagram of the fuel injection apparatus according to the present invention.

Fig. 11 is a back view of the fuel injection apparatus according to the present invention.

Fig. 12 is a schematic diagram of the fuel injection apparatus (modification) according to the present invention.

[0011] Referring to attached drawings, an embodiment of the present invention will be described below. Terms "front", "rear", "left", "right", "up" and "down" means directions viewed from a driver. The drawings are to be viewed so that the reference numerals can be seen in the right direction.

[0012] Fig. 1 is a left side view of a motorcycle according to the present invention. A motorcycle 10 mainly includes a cradle type vehicle body frame 20, a front fork 31 mounted to a head pipe 21 of the vehicle body frame 20, a front wheel 32 attached to the front fork 31, a handle 33 connected to the front fork 31, a fuel tank 34 and an air chamber 35 mounted on the vehicle body frame 20, a seat rail 40 extending rearward from the vehicle body frame 20, a front seat 51 and a rear seat 52 mounted on the seat rail 40, a four-cycle engine 53 disposed in a cradle space of the vehicle body frame 20, a muffler 55 connected to an exhaust port of the engine 53 via an exhaust pipe 54, a swing arm 56 suspended by a rear cushion (not shown) from the rear portion of the vehicle body frame 20, and a rear wheel 57 attached to the swing arm 56, and is a vehicle in which a vehicle body 11 is covered with a cowl 58 indicated by imaginary lines, that is, a vehicle of full cowling type.

[0013] The vehicle body 11 includes the vehicle body frame 20 and the seat rail 40. The seat rail 40 is a rear frame supporting the seats (front and rear seats 51, 52). A driver can sit on the front seat 51 and a fellow passenger can sit on the rear seat 52.

[0014] The exhaust pipe 54 is a metal pipe starting from the exhaust port provided on the front portion of the engine 53, passing under the engine 53, extending rearward of the vehicle body frame 20, and from the rear end thereof, extending upward along the vehicle body frame 20, and then from the upper end thereof, extending along the seat rail 40 to the muffler 55. Reference numeral 61 represents a heat shielding pipe for covering the exhaust pipe 54, reference numeral 62 represents a heat shielding plate for covering the upper portion of the muffler 55, and reference numeral 67 represents a protector for covering the left and the right rear portions of the muffler 55. The protector 67 is a protecting plate mounted to a stay 81 for mounting a rear fender 82.

[0015] As described above, in the motorcycle 10, the front wheel 32, the engine 53, and the rear wheel 57 are mounted from the front to the rear in this order on the vehicle body 11, the exhaust pipe 54 extends rearward from the engine 53, the muffler 55 is attached at the rear end of the exhaust pipe 54, and the muffler 55 is disposed on the rear portion of the vehicle body frame 20 between the left and the right seat rails of the seat rail 40 above the rear wheel 57.

[0016] In the drawing, reference numeral 63 represents a front fender, numeral 64 represents a radiator, numeral 65 represents a stand, numeral 72 represents a battery, numeral 74 represents a key cylinder, the numeral 82 represents a rear fender, numeral 84 represents a number plate, numeral 85 represents a license plate lamp, numeral 86 represents a winker, and 87 represents a tail lamp.

[0017] Fig. 2 is a left side view of a vehicle body according to the present invention, and Fig. 3 is a plan view of a vehicle body according to the present invention. In Fig. 2 and Fig. 3, the vehicle body frame 20 includes the head pipe 21, left and right main frames 22, 22 extending rearward from the head pipe 21, left and right center frames 23, 23 extending downward from the rear ends of the main frames 22, 22 (only the left center frame is shown in the figure, hereinafter), left and right down frame 24, 24 extending from the head pipe 21 and the front portions of the main frames 22, 22 downward toward the rear, left and right upper frames 25, 25 extending from the lower ends of the down frames 24, 24 toward the rear portions of the main frames 22, 22, and a plurality of cross members, which are not shown in the drawing.

Part or all these frame components are formed by metal casting.

[0018] The down frames 24, 24 include left and right through holes 24a, 24a at the front portions thereof so as to communicate the inside and the outside. Air intake pipes 66, 66 shown by imaginary lines can be inserted through these through holes 24a, 24a. The air intake pipes 66, 66 connect air vents 58a, 58a formed on the front portion of the cowl 58 and the air intake ports 35a, 35a of the air chamber 35. Alternatively, the through holes 24a, 24a may be utilized as parts of the air intake pipes 66, 66.

[0019] The vehicle body frame 20 includes left and right brackets 26, 26 extending upward from the upper rear portions of the left and the right main frames 22, 22. The left and the right brackets 26, 26 are supporting members including fuel tank supporting portions 27, 27 on the front portions thereof and seat rail mounting portions 28, 28 on the rear portions thereof. By mounting the seat rail 40 to seat rail mounting portions 28, 28 via bolts 29... (...represents plural, hereinafter), the seat rail 40 can be extended rearward from the upper rear portion of the vehicle body frame 20. The fuel tank supporting portions 27, 27 are through holes pierced widthwise of the vehicle.

[0020] Fig. 4 is a plan view of the seat rail according to the present invention, and Fig. 5 is an exploded drawing of the seat rail according to the present invention.

The seat rail 40 includes a left seat rail 40L and a right seat rail 40R divided along the centerline CL of the

vehicle extending in the longitudinal direction. Three cross members, that is, a upper front cross member 47, a lower front cross member 48, and a rear cross member 49, are disposed in this order from the front to the rear across the left and the right seat rails 40L, 40R.

[0021] The left and the right seat rails 40L, 40R, being constructed of left and right halves each having substantially flat upper and lower surfaces, are formed by casting. In other words, the left and the right seat rails 40L, 40R includes surfaces extending laterally of the vehicle (upper and lower surfaces) being substantially flat for enabling fabrication with a split mold, which can be divided laterally of the vehicle, when being molded.

[0022] Such left and right seat rails 40L, 40R include rail mounting portions 41 ... at the front end (left side of the drawing), fuel tank supporting portions 42, 42 formed behind the rail mounting portions 41 ... , upper front coupling parts 43, 43 and lower front coupling parts 44, 44 formed behind the fuel tank supporting portions 42, 42, rear coupling parts 45, 45 formed behind the lower front coupling potions 44, 44, extensions 48, 48 extending from the rear ends (right side of the drawing) toward the centerline CL extending longitudinally of the vehicle, and flanges 46a, 46a for mating the extremities thereof with respect to each other, all of which are formed integrally.

The fuel tank supporting portions 42, 42 are through holes formed so as to pierce widthwise of the vehicle.

[0023] The left and the right seat rails 40L, 40R are combined with each other by the steps of (1) superimposing the upper front cross member 47 on the upper front coupling parts 43, 43 from above so as to extend across therebetween and securing by securing members B1... such as bolts, (2) sandwiching the ends of the lower front cross member 48 between the lower front coupling parts 44, 44 and securing with securing members B2 ... such as bolts, (3) superimposing the rear cross member 49 on the rear coupling parts 45, 45 from above and securing by securing members B3 ... such as bolts, and (4) mating the flanges 46a, 46a with respect to each other and securing them with securing members B4... such as bolts.

[0024] In this manner, the seat rails 40 are casting having a substantially flat upper surface, including at least one cross member 47-49, and the cross member 47-49 can be mounted by a securing member B1-B4 such as bolts after assembly.

[0025] As shown in Fig. 5, a hook plate 68 (seat mounting member 68) formed of a plate material may be mounted to the extensions 46, 46 by securing members B5, B5 such as bolts after assembly. The hookplate 68 is a member for mounting the rear portion of the rear seat 52 (See Fig. 1).

[0026] Fig. 6 is a left side view of an area around the engine, the fuel tank, and the air chamber according to the present invention, showing that the air chamber 35 is disposed immediately above the engine 53, and the fuel tank 34 is disposed at the immediately behind and adjacent to the air chamber 35 with a gap Dl being formed therebetween.

[0027] The fuel tank 34 includes a front wall 91 and a bottom plate 92 being substantially flat, a fuel port 94 formed on an upper plate 93, a fuel pump 95 on the bottom thereof, and mount portions formed on left and right side plates 96, 96 (first, second, third, and fourth mount portions 110A-110D).

[0028] As is clear from this drawing, the upper surface of the fuel tank 34 is at the level slightly higher than the upper surface of the air chamber 35. By bending only the upper portion of the front wall 91 so as to be concave on the lower side, and extending the same slightly toward the front, only the upper rear portion of the air chamber 35 is covered by an extension 97. Upper half of the fuel tank 34 and the upper half of the air chamber 35, that is, the portion projecting above the vehicle body frame 20 is covered by a cover 98. The cover 98 is detachably mounted to the vehicle body frame 20.

[0029] The engine 53 is a four-cylinder engine, and is provided with a fuel injection apparatus 100. This drawing shows that air intake passages 101 ... are connected to air inlet ports 53a... (aligned in the direction of front and back sides of the drawing) for each cylinder, and throttle valves 102.... are provided in the respective air intake passages 101 ... , and the air chamber 35 is provided on the upstream ends of the air intake passages 101....

[0030] The fuel injection apparatus 100 is constructed in such a manner that first fuel injection valves 103 ... are mounted to the air chamber 35 on the upstream side of the throttle valves 102... for the respective cylinders, and second fuel injection valves 104... are mounted to the air intake passages 101... on the downstream side of the throttle valves 102 ... for the respective cylinders. In this manner, the first fuel injection valves 103... are provided on the engine 53 on the upstream side of the air intake passages 101 ... and the second fuel injection valves 104... are provided on the downstream side of the air intake passages 101....

[0031] The first fuel injection valves 103 ... are disposed at the level higher than the second fuel injection valves 104, that is, the second fuel injection valves 104 ... are disposed at the level lower than the first fuel injection valves 103 ....

Only the second fuel injection valves 104... are used when the engine 53 is in a low-power operation, and the first fuel injection valves 103... and the second fuel injection valves 104... are used in combination when in a high & low-power operation, so that the performance of the engine 53 is enhanced.

[0032] In other words, the second fuel injection valves 104 ... provided in the air intake passage 101 are, so called, fuel injection valves for low-sped operation of the engine 53, which inject fuel when the number of revolution of the engine 53 is low.

The first fuel injection valves 103 ... provided in the

air chamber 35 are, so called, fuel injection valves for high-sped operation of the engine 53, which inject fuel when the number of revolution of the engine 53 is high.

When the revolution of the engine 53 is low, fuel is supplied to the air intake passage 101 in the vicinity of the combustion chamber of the engine 53 from the second fuel injection valves 104..., and thus responsibility of the amount supplied is improved.

[0033] The fuel pump 95 includes a discharge port 95a at the lower end thereof, and the first fuel injection valves 103 ... can be connected to the discharge port 95a by a first fuel feed pipe 105, and the first fuel injection valves 103... can be connected to the second fuel injection valves 104 ... by a second fuel feed pipe 106. Therefore, fuel in the fuel tank 34 can be supplied to the first and the second fuel injection valves 103..., 104... by the fuel pump 95.

[0034] Furthermore, the first and the second fuel feed pipes 105, 106 are formed, for example, of a hose, and can be passed through the gap DI between the front wall 91 of the fuel tank 34 and the rear portion of the air chamber 35.

[0035] Fig. 7 is a left side cross-sectional view of the fuel injection apparatus according to the present invention, showing a cross-sectional construction of the air chamber 35 in the fuel injection apparatus 100. Fig. 8 is a plan view of the fuel injection apparatus according to the present invention.

The air chamber 35 is a container of resin mold divided into upper and lower halves, that is, a lower chamber 130 which corresponds to the lower hall, and an upper chamber 140 which corresponds to the upper half, secured with each other by screws 151....

[0036] The lower chamber 130 is a container opened on top, including a substantially horizontal lower wall 131 (bottom plate 131) connected to the upstream end of the air intake passages 101...(only one air intake passage is shown in the drawing, hereinafter), a front wall 132 (front plate 132) extending frontward and upward from the front end of the lower wall 131, a rear wall 133 (rear plate 133) extending upward from the rear end of the lower wall 131, and left and right side walls 134, 134 (side plates 134, 134).

The lower wall 131 is provided with a plurality of airline pipes (funnels) 135 continuing to the respective upstream ends of the plurality of air intake passages 101..., and the extremities of the airline pipes 135... are opened.

[0037] The upper chamber 140 is a container opened at the bottom, including an upper wall 141 (top plate 141) facing the lower wall 131 and the front wall 132 of the lower chamber 130, and a front wall 142 (front plate 142) extending downward from the front end of the upper wall 141, and a rear wall 143 (rear plate 143) extending downward from the rear end of the upper wall 141, and left and right walls 144, 144 (side plates 144, 144).

[0038] It can be said that the upper wall 141 is a wall facing the lower wall 131 continuing to the upstream end of the air intake passages 101... among the walls constituting the air chamber 35. Such upper wall 141 is provided with the plurality of first fuel injection valves 103... injecting fuel toward the respective upper stream ends of the air intake passages 101..., that is, toward openings 135a... at the extremities of the respective airline pipes 135....

[0039] More specifically, the first fuel injection valves 103 ... are mounted to metallic mounting members 152..., and gaps formed between the mounting members 152 ... and the first fuel injection valves 103 ... are sealed with water-resistant rubber grommet (sealing member) 153 ..., so that assembling units are provided. Then, the mounting members 152... are mounted to the upper wall 141 with bolts and nuts 159... (See Fig. 8). The first fuel injection valves 103 ... can be mounted to the upper wall 141 via the metallic mounting members 152....

Since the first fuel injection valves 103 ... are mounted to the air chamber 35 via the metallic mounting members 152 ..., mounting rigidity as well as mounting accuracy may be improved.

[0040] In this manner, provision of first fuel injection valves 103..., which inject fuel toward the upstream end of the air intake passage 101, enables fuel piping (first and the second fuel feed pipes 105, 106) shown in Fig. 8 and wiring 154 shown in Fig. 7 to be connected to the first fuel injection valves 103... outside the air chamber 35.

[0041] Since the first fuel injection valves 103... can be attached to and detached from the air chamber 35 from the outside thereof, it is not necessary to disassemble the air chamber 35 for performing maintenance and inspection of the first fuel injection valves 103.... Therefore, maintenanceability and inspection capability may be improved. In addition, since the first and the second fuel feed pipes 105, 106 and wiring 154 can be connected to the first fuel injection valves 103... outside the air chamber 35, assemblability, maintenanceability, and inspection capability may be improved.

[0042] In addition, since the first and the second fuel feed pipes 105, 106 and the wiring 154 do not pass through the wall of the air chamber 35, it is not necessary to provide a sealing mechanism (air-tight, water-tight mechanism) at a pierced portion. Therefore, the number of components of the fuel injection apparatus 100 may be reduced, and thus the construction may be simplified.

[0043] In addition, since the first fuel injection valves 103 ... are not disposed in the air chamber 35, the capacity of the air chamber 35 can easily be secured, and flowing resistance of air (air resistance) flowing in the air chamber 35 may be reduced.

Furthermore, even in the air chamber 35 having limited capacity, such as those to be mounted on the motorcycle 10 (See Fig. 6), the first fuel injection valves 103 ... may be mounted at the positions away from the air intake passage 101.

[0044] The air chamber 35 also serves as an air clean-

er case provided with a filter element 155. Since the air chamber 35 serves as the air cleaner case, a specific space for arranging the air cleanse case is not necessary.

More specifically, as described above in conjunction with Fig. 2 and Fig. 3, the air chamber 35 is provided with the air intake ports 35a, 35a on the left and the right sides of the front portion of the lower chamber 130.

[0045] A rectangular plate shaped filter element 155 is disposed in the air chamber 35, and a frame body 155a on the edge of the filter element 155 is removably attached to the lower chamber 130. More specifically, the filter element 155 is disposed in parallel with the inclined front wall 132 of the lower chamber 130, the lower end of the frame body 155a is hooked at the hooking potion 156 (set plate 156) of the lower chamber 130, and at least an upper end of the frame body 155a is secured to the lower chamber 130 with screws 157....

[0046] The internal space of the air chamber 35 may be partitioned by the filter element 155 into a primary side which communicate with the air intake ports 35a, 35a and a secondary side which communicates with the airline pipes 135 .... As a matter of course, the first fuel injection valves 103 ... and the airline pipes 135... are disposed on the secondary side.

[0047] In this manner, the filter element 155 is disposed in a state of inclining toward the upright posture with respect to a mating surface 159 between the lower chamber 130 and the upper chamber 140. Therefore, even when the dimension of the air chamber 35 in the fore-and-aft direction is small, the filter element 155 may be formed into a simple construction such as a flat-plate shape, the area of the filter may be maximized, and the capacity on the secondary side may be increased. That is, the ratio of the capacity of the secondary side with respect to the capacity on the primary side increases.

[0048] In addition, the air chamber 35 includes a large inspection port 145 on the upper surface thereof, that is, on the upper wall 141 of the upper chamber 140, so as to extend to the position near the first fuel injection valves 103 ..., and a lid 146 removably closing the inspection port 145. It is possible to provide the inspection port 145 on the front side and the first fuel injection valves 103 .... on the rear side of the air chamber 35.

[0049] In this manner, the inspection port 145 may be provided on the wall surface on which the first fuel injection valves 103 ... are not provided (the portion of the upper wall 141 on which the first fuel injection valves 103 ... are not provided) among the walls constituting the air chamber 35.

Since maintenance and inspection of the filter element 155 may be performed only by removing the lid 146, operability may be improved.

[0050] "The wall surface on which the first fuel injection valves 103... are not provided among the walls constituting the air chamber 35" includes all the portion of the walls constituting the air chamber 35 on which the first fuel injection valves 103... are not provided. For example, as shown in Fig. 7, the upper wall 141 is provided with the first fuel injection valves 103.... However, the inspection port 145 may be formed on the portion of the upper wall 141 on which the first fuel injection valves 103... are not provided.

[0051] In addition, the lid 146 as a wall constituting the air chamber 35 is provided with an electrical component 161 for controlling the first and the second fuel injection valves 103 ..., 104 ... in the vicinity of the first fuel injection valve 103.... The upper space of the air chamber 35 can be effectively utilized.

More specifically, a flat recessed mounting portion 146a is formed on the outer surface of the lid 146, and the electrical component 161 is placed and removably attached on the mounting potion 146a by snap-fitting with a resilient claw (one-touch attachment) or by screwing.

[0052] Since the electric component 161 for controlling the first and the second fuel injection valves 103 .... 104... may easily be provided in the vicinity of the first fuel injection valves 103 ... , the wiring 154 from the electric component 161 to the first and the second fuel injection valves 103 ... , 104 ... may be shortened. Therefore, weight saving of the motorcycle 10 as well as cost saving may be achieved.

Reference numeral 162 in the drawing represents a driven unit of a throttle valve control unit.

[0053] Fig. 9 is an exploded view of the air chamber according to the present invention. The cover 98 can be removed upward from the vehicle body frame 20 by removing the screws 99 .... When the cover 98 is removed, since the first fuel injection valves 103 ... , the first and the second fuel feed pipes 105, 106, and the wiring 154 shown in Fig. 7 and Fig. 8 are exposed, maintenance and inspection can be performed. In particular, since maintenance and inspection of the plurality of first fuel injection valves 103... can be performed from both sides of the vehicle body, the workability is significantly good.

[0054] Maintenance and inspection of the filter element 155 are performed in the following manner.

In a first place, the cover 98 is removed, and then the lid 146 is removed.

Then, the screws 157... securing the upper portion of the filter element 155 are removed.

Subsequently, by pulling out the filter element 155 forward and upward, the lower end of the filter element 155 is pulled out from the hooking portion 156.

[0055] Since maintenance and inspection of the filter element 155 can be performed simply by removing the cover 98 and the lid 146 without disassemble the air chamber 35 or removing the first fuel injection valves 103... as described above, operability is good. Furthermore, since the lower end of the air chamber 35 is just hooked on the hooking portion 156, the attaching and detaching workability is good.

The filter element 155 can be stored again simply by following the procedure described above in reverse.

[0056] Subsequently, referring to Fig. 6, Fig. 8, Fig. 10, and Fig. 11, the fuel piping of the fuel injection apparatus 100 (first and second fuel feeding pipes 105, 106) will be described.

Fig. 10 is a schematic diagram of the fuel injection apparatus according to the present invention, showing a flow of fuel in the fuel injection apparatus 100 viewed from the rear side of the motorcycle 10. Fig. 11 is a back view of the fuel injection apparatus according to the present invention, showing the air chamber 35, the first and the second fuel injection valves 103 ... , 104 ... , and the first and the second fuel feed pipes 105, 106, viewed from the back side of the motorcycle 10.

[0057] Fig. 10 and Fig. 11 show that the fuel pump 95 is connected to the second fuel injection valves 104 ... via the first fuel injection valves 103... by the first and the second fuel feed pipes 105, 106 so that fuel does not flow back to the fuel tank 34. More specifically, a first header pipe 171 includes an outlet and an inlet of fuel (an inlet joint 172 and an outlet joint 173) on both ends. On the other hand, a second header pipe 181 includes only an inlet of fuel (inlet joint 182).

As shown in Fig. 8, the first header pipe 171 is mounted by the mounting members 152... with bolts and nuts 175....

[0058] More specifically, the plurality of first fuel injection valves 103 ... are connected in line with the first header pipe 171 formed of a straight pipe. The first header pipe 171 is provided with the inlet joint 172 at a left end (one end) 171a and the outlet joint 173 on a right end (the other end) 171b.

In the same manner, the plurality of fuel injection valves 104 ... are connected in line with the second header pipe 181 formed of a straight pipe. The second header pipe 181 is provided with the inlet joint 182 on a right end (one end) 181a .

[0059] The second header pipe 181 is not provided with an outlet joint as in the first header pipe 171. In other words, fuel will never comes out from a left end (the other end) 181b of the second header pipe 181.

The first and the second header pipes 171, 181 are also referred to as delivery pipes or fuel pipes.

[0060] The inlet joint 172 of the first header pipe 171 can be connected to the outlet port 95a of the fuel pump 95 by the first fuel feed pipe 105, and the inlet joint 182 of the second header pipe 181 can be connected to the outlet joint 173 of the first header pipe 171 by the second fuel feed pipe 106. In other words, the number of joint parts can be reduced, and hence the number of components by connecting the first fuel feed pipe 105, the first header pipe 171 (first fuel injection valves 103 ...), the second fuel feed pipe 106, the second header pipe 181 (second fuel injection valves 104 ...) sequentially in this order to the fuel pump 95.

[0061] Fuel supplied from the fuel tank 34 by the fuel pump 95 flows along a route from the first fuel feed pipe 105 through the inlet joint 172, the first header pipe 171, the outlet joint 173, the second fuel feed pipe 106, and the inlet joint 182, to the second header pipe 181. Therefore, fuel can be supplied to the first and the second fuel injection valves 103 .... 104... via the first and the second header pipes 171, 181.

[0062] While the engine 53 is in operation, fuel is constantly injected from the second fuel injection valves 104.... Therefore, even when a small quantity of air is mixed in fuel in fuel piping, it is injected in an early stage and constantly from the second fuel injection valves 104.... Consequently, the quantity of air trapped in the first header pipe 171 or in the first fuel injection valves 103 ... located at a higher level is negligible, and thus the engine 53 can maintain a stable performance.

[0063] A return pipe for returning fuel to the fuel tank 34 or to the fuel pump 95 from the first and the second header pipes 171, 181 is not provided. Therefore, fuel will never be returned to the fuel tank 34 or the fuel pump 95.

[0064] As shown in Fig. 6, Fig. 8, Fig. 10, and Fig. 11, the first fuel feed pipe 105 extends upward from the outlet port 95a of the fuel pump 95 located at the laterally center, passes through the gap DI between the fuel tank 34 and the air chamber 35, turns to the left in the lateral direction of the vehicle, and is connected to the inlet joint 172 at the left end 171a of the first header pipe 171.

In this connection, when the fuel tank 34 is connected to or disconnected from the vehicle body frame 20, the fuel tank 34 can be moved upward and downward in a state in which the first fuel feed pipe 105 is connected to the fuel pump 95.

[0065] On the other hand, the second fuel feed pipe 106 passes through the right side of the engine 53 (See Fig. 6) so that the outlet joint 173 at the right end 171b of the first header pipe 171 and the inlet joint 182 of the right end 181a of the second header pipe 181 are connected. Since a cam chain (a chain connecting a crankshaft and a cam shaft) passed through the right side of the engine 53, a space around there can be effectively utilized.

When the cam chain passed through the left side of the engine 53, the piping must simply be reversed from the construction described above.

[0066] Fig. 12 is a schematic diagram of the fuel injection apparatus (modification) according to the present invention, showing a flow of fuel of the fuel injection apparatus 100 when viewed from the rear of the motorcycle 10. The same constructions as in the embodiment shown in Fig. 6 to Fig. 11 are represented by the same reference numerals and will not be described again.

[0067] This drawing shows that the fuel pump 95 is connected to the first fuel injection valves 103 ... via the second fuel injection valves 104... by the first and the second fuel feed pipes 105, 106 so that fuel does not flow back to the fuel tank 34.

More specifically, the first header pipe 171 includes only the inlet for fuel (inlet joint 172). On the other hand, the second header pipe 181 includes the outlet

and the inlet (inlet joint 182 and outlet joint 183) of fuel at the both ends.

[0068] In detail, the first header pipe 171 is provided with the inlet joint 172 at the right end (the other end) 181b. The first header pipe 171 is not provided with the outlet joint. Therefore, fuel will not come out from the left end (one end) 171a of the first header pipe 171.

On the other hand, the second header pipe 181 is provided with the inlet joint 182 on the left end (the other end) 181b and the outlet joint 183 at the right end (one end) 181a.

[0069] The inlet joint 182 of the second header pipe 181 can be connected to the outlet port 95a of the fuel pump 95 by the first fuel feed pipe 105, and the inlet joint 172 of the first header pipe 171 can be connected to the outlet joint 183 of the second header pipe 181 by the second fuel feed pipe 106. In other words, the number of joint parts and hence the number of components can be reduced by connecting the first fuel feed pipe 105, the second header pipe 181 (second fuel injection valves 104 ...), the second fuel feed pipe 106, the first header pipe 171 (first fuel injection valves 103...) sequentially in this order to the fuel pump 95.

[0070] Fuel supplied from the fuel tank 34 by the fuel pump 95 flows along the route from the first fuel feed pipe 105 through the inlet joint 182, the second header pipe 181, the outlet joint 183, the second fuel feed pipe 106, and the inlet joint 172, to the first header pipe 171. Therefore, fuel can be supplied to the first and the second fuel injection valves 103..., 104... via the first and the second header pipes 171 ,181.

[0071] Fuel is fed from the fuel pump 95 to the second header pipe 181, which is located at the lower level on ahead. While the engine 53 is in operation, fuel is constantly injected from the second fuel injection valves 104..., which is located at the lower level. Therefore, even when a small quantity of air is mixed in fuel piping, it is injected in an earlier stage and constantly from the second fuel injection valves 104 .... Consequently, the quantity of air trapped in the first header pipe 171 or in the first fuel injection valves 103 ... located at a higher level is negligible, and thus the engine 53 can maintain its performance in more stable manner.

[0072] A return pipe for returning fuel to the fuel tank 34 or to the fuel pump 95 form the first and the second header pipes 171, 181 is not provided. Therefore, fuel will never be returned to the fuel tank 34 or the fuel pump 95.

[0073] In this manner, since the second fuel injection valves 104... are disposed at a level lower than the first fuel injection valves 103 ..., and the fuel pump 95 is connected to the second fuel injection valves 104... via the first fuel injection valves 103 ..., or to the first fuel injection valves 103... via the second fuel injection valves 104 ... by the first and the second fuel feed pipes 105, 106, so that fuel does not return to the fuel tank 34, return piping is not necessary, and thus the number of fuel feed pipes may be reduced correspondingly, and the number of joints (joint parts) of the fuel feed pipes may be reduced as well. Therefore, fuel piping may be simplified. In addition, since maintenance and inspection are facilitated, the workability is improved. The invention enables reduction of the numbers of the pipes in fuel piping and joint parts and to facilitate piping work, maintenance and inspection work.

An engine fuel injection apparatus 100 includes first fuel injection valves 103 ... provided on an upstream side of an air intake passage of an engine, second fuel injection valves 104 ... provided on a downstream side of the air intake passage, and a fuel pump 95 for supplying fuel to the first and the second fuel injection valves. The second fuel injection valve is positioned at a level lower than the first fuel injection valves, and the fuel pump is connected to the second fuel injection valves via the first fuel injection valves by fuel feed pipes 105, 106 so that fuel does not return to a fuel tank 34.

Claims

1. An engine fuel injection apparatus comprising:

   a first fuel injection valve (103) provided on an upstream side of an air intake passage (101) of an engine;
   a second fuel injection valve (104) provided on a downstream side of the air intake passage (101); and
   a fuel pump (95) for supplying fuel to the first and the second fuel injection valves,

   characterized in that the fuel pump (95) is connected to the second fuel injection valve (104) via the first fuel injection valve (103) or to the first fuel injection valve (103) via the second fuel injection valve (104) by a fuel feed pipe (105, 106), so that fuel does not return to a fuel tank.

2. An engine fuel injection apparatus according to claim 1,
   characterized in that the fuel pump (95) is connected to the second fuel injection valve (104) via the first fuel injection valve (103) by the fuel feed pipe (105, 106),
   in that the first fuel injection valve (103) is a fuel injection valve for the high-speed operation that injects fuel when the number of revolution of the engine (53) is high, and
   in that the second fuel injection valve (104) is a fuel injection valve for the low-speed operation that injects fuel when the number of revolution of the engine (53) is low.

3. An engine fuel injection apparatus according to claim 1,
   characterized in that the fuel pump (95) is con-

nected to the first fuel injection valve (103) via the second fuel injection valve (104) by the fuel feed pipe (105, 106) and in that the first fuel injection valve (103) is disposed at the level higher than the second fuel injection valve (104).

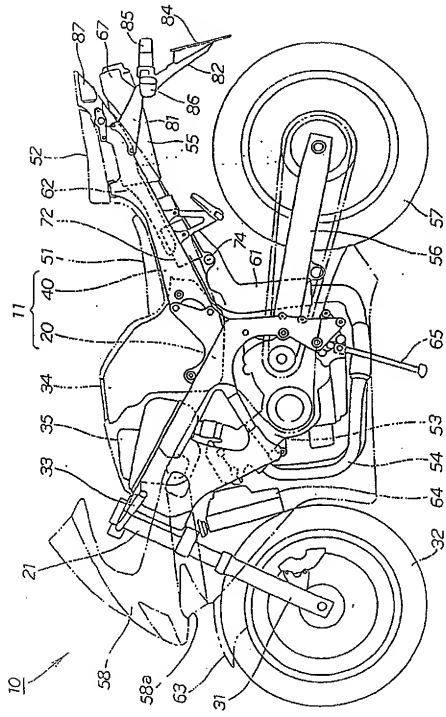

FIG. 1

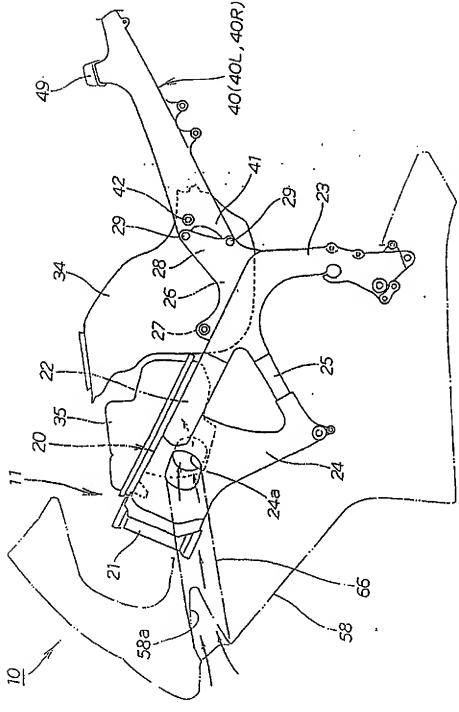

FIG. 2

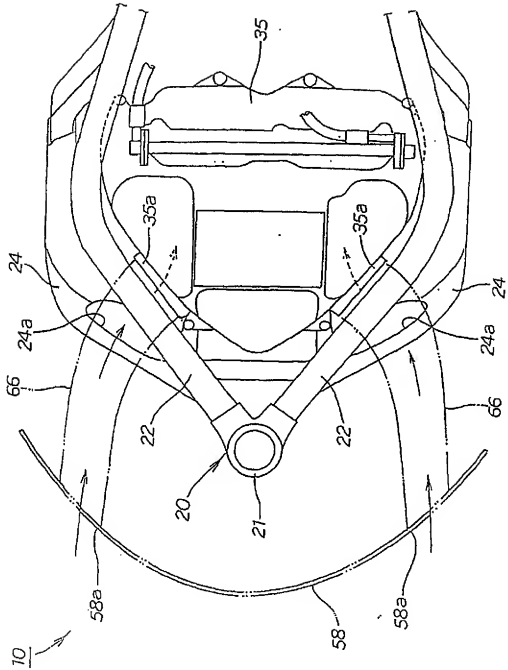

FIG. 3

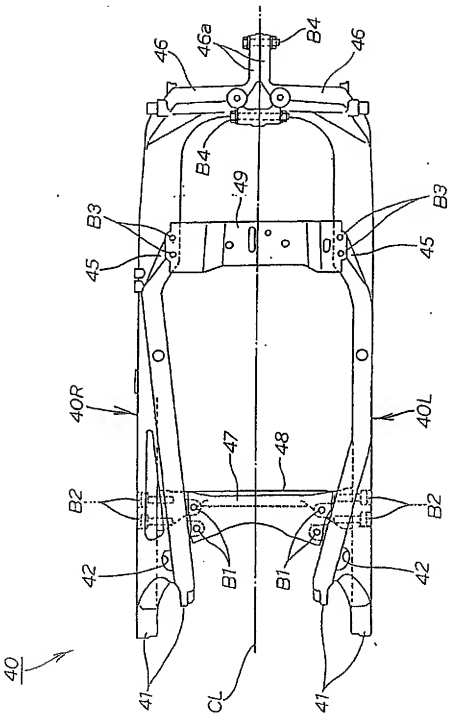

FIG. 4

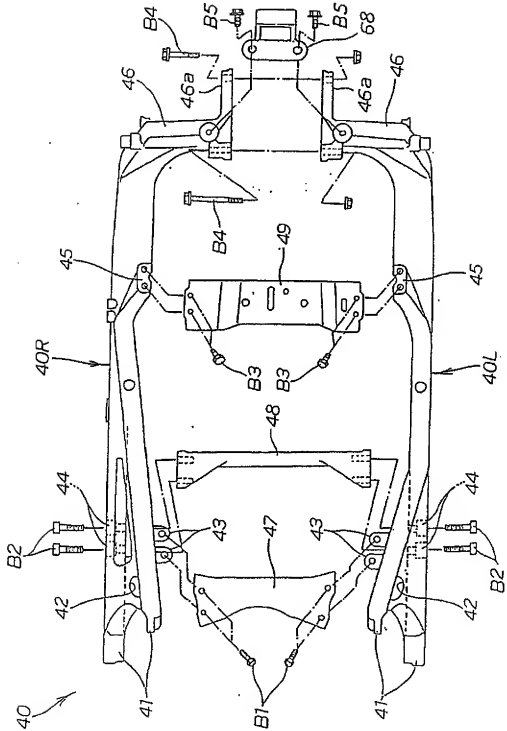

FIG. 5

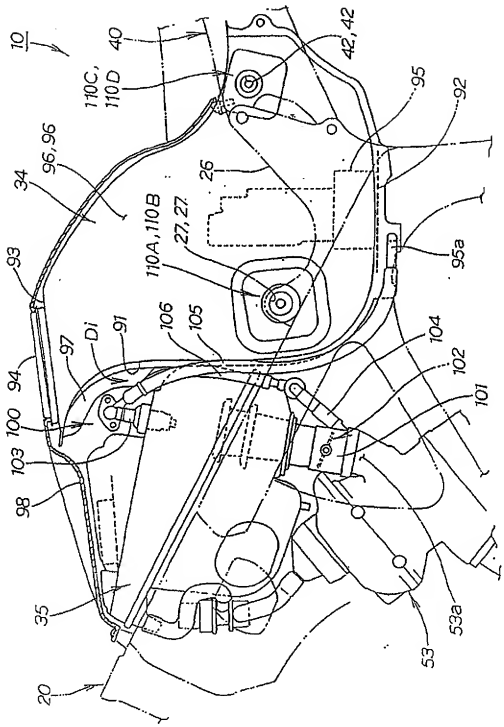

FIG. 6

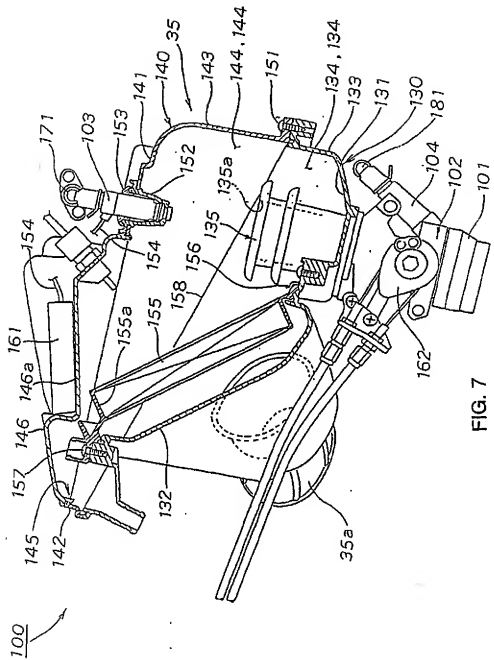

FIG. 7

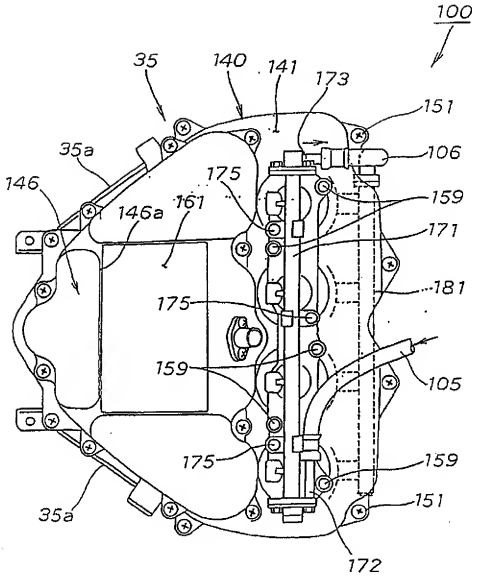

FIG. 8

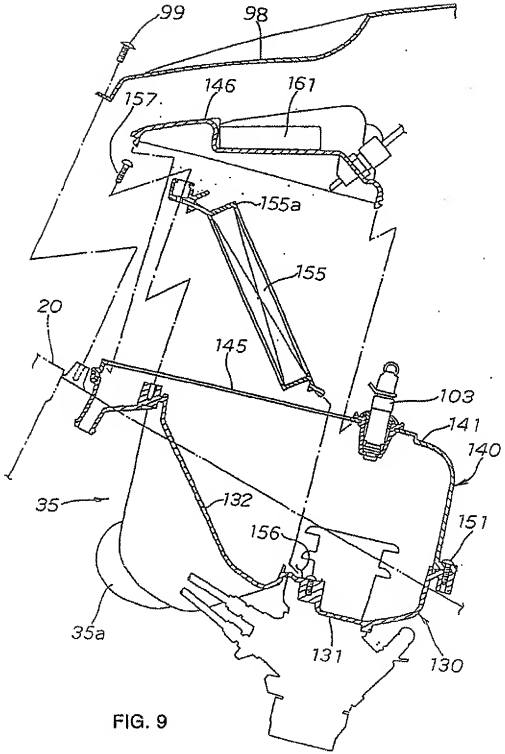

FIG. 9

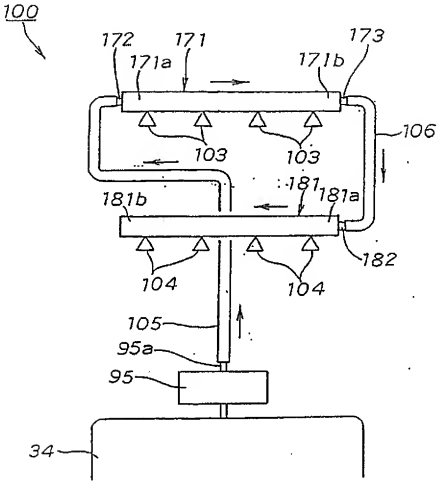

FIG. 10

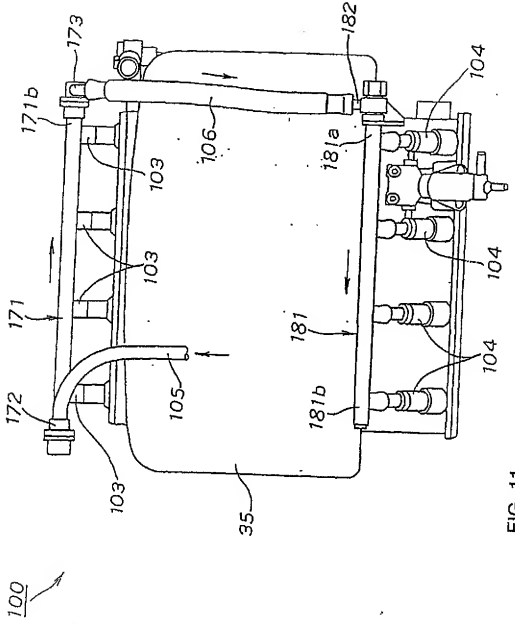

FIG. 11

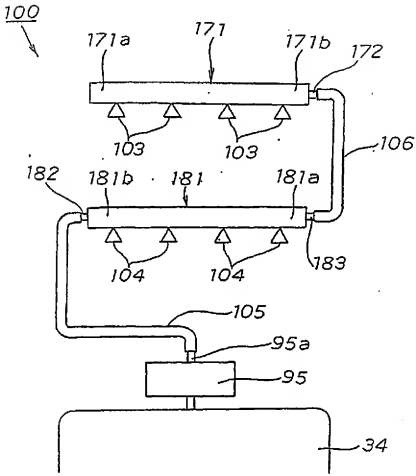

FIG. 12

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 01 8133

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 21, 3 August 2001 (2001-08-03) -& JP 2001 115919 A (HONDA MOTOR CO LTD), 27 April 2001 (2001-04-27) * abstract * ---	1-3	F02M69/04 F02M61/14
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	13 October 2003	Wagner, A

CATEGORY OF CITED DOCUMENTS

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13-10-2003

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82